Journal of Neurolinguistics 40 (2016) 79–97

Contents lists available at ScienceDirect

Journal of Neurolinguistics

journal homepage: www.elsevier.com/locate/jneuroling

Direction matters: Event-related brain potentials reflect extra processing costs in switching from the dominant to the less dominant language

Chia-Hsuan Liao [1], Shiao-Hui Chan*

Department of English, National Taiwan Normal University, Taiwan

ARTICLE INFO

Article history:
Received 15 October 2014
Received in revised form 7 June 2016
Accepted 13 June 2016
Available online 22 June 2016

Keywords:
BIA+ model
Bilingual sentence processing
Language switching
Language dominance
Cloze probability
Cognitive control

ABSTRACT

Language switching is common in bilingual processing, and it has been repeatedly shown to induce processing costs. However, only a handful of studies have examined such costs at the sentence level, with a limited few among them having incorporated factors extensively studied in monolingual sentence processing, such as semantic expectedness. Using the event related potentials (ERP) technique, this study aimed at exploring whether switching costs were modulated by (1) switching directions, when switching happens between languages of different dominance, and by (2) semantic expectedness, as indicated by cloze probability. Twenty-two Mandarin-Taiwanese early bilinguals, with Mandarin being their dominant and Taiwanese their non-dominant language, participated in the study. They were instructed to listen to the stimuli attentively and to perform a word memory recognition task in 20% of the trials. The results showed that switching induced an LPC effect, suggesting that switched elements were harder to be integrated. More importantly, switching from the dominant to the non-dominant language demanded extra effort than switching in the other direction, as reflected by the PMN (detection of an unexpected sound), the N400 (indication of lexical access difficulty) and the frontal negativity (inhibition of the pre-activated representations), revealing that the dominant language provides better prediction of the upcoming word. Also, cloze probability interacted with switching, but only at an early stage, suggesting that semantic expectedness did not enduringly modulate the switching cost. Our results generally supported predictions from the Bilingual Interactive Activation Plus model (BIA+ model, Dijkstra & van Heuven, 2002), showing that language use and sentence context can affect lexical processing in bilinguals.

1. Introduction

Most people can respond to another interlocutor immediately in conversations, or sometimes can even fill in a particular word that the other person fails to produce because people automatically predict upcoming words in speech (Li, 2001; Sacks, Schegloff, & Jefferson, 1974; Schegloff, 2000). However, there are circumstances in which the prediction does not match what is actually perceived; in such cases, the input has to be reanalyzed (Friederici, Pfeifer, & Hahne, 1993). Speech becomes even

* Corresponding author. National Taiwan Normal University, No. 162, Sec. 1, HePing E. Rd., Taipei, 106, Taiwan.
E-mail address: shiaohui@ntnu.edu.tw (S.-H. Chan).
[1] Current address: Department of Linguistics, University of Maryland, United States.

http://dx.doi.org/10.1016/j.jneuroling.2016.06.004
0911-6044/

more unpredictable when bilingual speakers are involved in a conversation because the speakers can freely switch back and forth between languages depending on the topics, interlocutors and social contexts (Grosjean, 2001, 2008; Myers-Scotton, 1998). Since language switching is such a common phenomenon in a bilingual society, it is one of the extensively studied topics in bilingual language processing.

In the domain of language production, behavioral studies reveal that people take longer to name a switched word, especially when the word is switched from the second language (L2) to the first language (L1) (e.g., Meuter & Allport, 1999). However, studies in language comprehension do not yield a consistent picture regarding switching direction, probably due to different materials, tasks and/or language proficiency of participants (Bobb & Wodniecka, 2013; Dijkstra, 2005; Van Hell & Witteman, 2009; van Hell, Litcofsky, & Ting, 2015). For example, experiments with single item materials find switching costs in either L2-L1 or L1-L2 direction. Using a priming paradigm with masked primes, Chauncey, Grainger and Holcomb (2008) observed a larger N400 for targets switched into L1 as compared to non-switched ones. In contrast, using a translation priming paradigm, Alvarez, Holcomb, and Grainger (2003) reported that stimuli switched from L1 to L2 taxed more cognitive effort than those switched in the other direction, as reflected by a larger N400 in the former case. Similarly, Phillips, Klein, Mercier, and de Boysson (2006) used a repetition priming paradigm and found that the N400 effect was present in processing auditory materials switched from L1 to L2 but not from L2 to L1.

Studies with sentential materials also find switching costs in either L1-L2 or L2-L1 direction. Moreno, Federmeier, and Kutas (2002) examined how English-Spanish bilinguals processed English sentences completed by an English expected word, an English synonym of the expected word (lexical switch), and a Spanish equivalent of the expected word (code switch). Their findings showed that, while the English synonyms elicited a stronger N400, the Spanish equivalents induced a stronger left anterior negativity (LAN) and late positive complex (LPC). The authors argued that the LAN effect could have resulted from different morphological agreements between Spanish and English and that the LPC effect might have reflected sentence reanalysis, as in semantically incongruous sentences or garden-path sentences in monolingual studies (Kim & Osterhout, 2005; Osterhout, Holcomb, & Swinney, 1994). Different from Moreno et al.'s study where the L1 (English) to L2 (Spanish) switching direction was investigated in English-Spanish bilinguals, Ng, Gonzalez, and Wicha (2014) and van der Meij, Cuetos, Carreiras, and Barber (2011) investigated sentences switched from L2 (English) to L1 (Spanish) in Spanish-English bilinguals. As in the language switching condition (i.e., code switch) in Moreno et al.'s (2002) study, a LAN effect and an LPC effect were observed in Ng et al.'s (2014) study. However, the data pattern in van der Meij et al.'s (2011) research was less straightforward: while the high-proficient group showed the LAN, N400 and LPC effects, the low-proficient group demonstrated the N400 and LPC effects without the LAN.

Proverbio, Leoni, and Zani's (2004) research was the first ERP study to explicitly manipulate the factor of switching direction in sentence context. The participants, who were interpreters and thus proficient in both Italian (L1) and English (L2), showed a larger N400 in comprehending L1-L2 switches than L2-L1 ones. Proverbio et al.'s finding of the asymmetric N400 effect in the L1-L2 direction was in line with those in Alvarez et al.'s (2003) and Phillips et al.'s (2006) single word studies, but the absence of the LAN and LPC effects did not replicate the patterns in Moreno et al.'s (2002) report. Later research suggested that the absence of an LPC effect can be contributed by factors such as participants' language proficiency, predictability of a switch, and the nature of the experimental task (Brouwer, Fitz, & Hoeks, 2012; Kuperberg, 2007; Moreno, Rodriguez-Fornells, & Lanie, 2008; van Hell & Witteman, 2009). The observation that switching costs might be modulated by language proficiency was also supported by a recent behavioral study examining switching direction, which observed a switching cost from L1 to L2 and found the cost correlated with L2 proficiency (Bultena, Dijkstra and van Hell et al., 2015).

Taken together, previous results do not unequivocally depict the relationship between processing costs (and their underlying cognitive processes) and switching direction in language comprehension, although all of them demonstrate that language switching per se results in some processing cost, such as difficulty in lexical access to the switched word (N400: Alvarez et al., 2003; Phillips et al., 2006; Proverbio, Leoni, & Zani, 2004), difficulty of grammatical processing of the morphological structure of the switched word (LAN: Moreno et al., 2002; Ng et al., 2014; van der Meij et al., 2011), and/or more effort in integrating a switched element into a sentence (LPC: Moreno et al., 2002; Ng et al., 2014; van der Meij et al., 2011).

But why is it more difficult to perceive a switched component? More specifically, why is it harder to process a switched component in a certain switching direction? The control/activation levels of bilinguals' two languages may provide an answer to the question. The Inhibitory Control Model (Green, 1998; henceforth IC model) claimed that switching in language production could induce costs because it involved a change in language schema for a given task and that any change of language involved overcoming the inhibition of the previous "language tags" that specified whether the lemmas belonged to L1 or L2 in the bilingual lexico-semantic system. Furthermore, since language tags in L1 were usually highly activated and more efforts were needed to inhibit them, producing an L2-L1 switch should be more difficult than producing an L1-L2 one since it was more demanding to reactivate a strongly inhibited L1 tag. However, it should be noted that in production, the language of the target word must be specified at an early stage for the target lexical item, but in perception, the processing is driven by the visual/acoustic input. Therefore, predictions of processing costs in comprehension can be different from those derived from the IC model. For example, being a comprehension model, the Bilingual Interactive Activation Plus model (Dijkstra & van Heuven, 2002; van Heuven & Dijkstra, 2010; henceforth BIA+) predicted switching costs in the L1-L2 direction. The model explicitly argued that the resting-level activation of words reflected the language user's subjective frequency of words and that linguistic context (e.g., a proceeding sentence) could influence the activation of lexemes in the word identification system. Hence, if a word was switched into another language, a processing cost should be observed because the activation of